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INSTRUCTIONS FOR

DECADE AMPLIFIER

MODEL 220C

BALLANTINE LABORATORIES, INC.
BOONTON, NEW JERSEY

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SPECIFICATIONS

BALLANTINE MODEL 220C DECADE AMPLIFIER

Frequency Range

10—150,000 c.p.s.

Voltage Amplification

10 times or 100 times (20 or 40 DB).
Maximum input voltage 50 millivolts for either gain.

Accuracy of Amplification

2% over entire frequency range.

Input Impedance

5 megohms shunted by a capacitance of 15 mmfds.

Output Impedance

Less than 900 ohms in series with 2 mfds. for 10 times gain.
Less than 7000 ohms in series with 2 mfds. for 100 times gain.

Tubes

Two 1U4. Tubes are supplied.

Batteries

Two Eveready Type 742; two Eveready Type 467. Batteries are supplied.

Dimensions

4½" high, 5¾" wide, 8¾" long

Weight

7¾ pounds

INSTRUCTIONS FOR

MODEL 220C DECADE AMPLIFIER

GENERAL — This instrument provides stable voltage gains of exactly 10 or 100 times over a frequency range extending from 10 to 150,000 cycles. It is operated by self-contained batteries having a life of over 150 hours. Either the 10 times gain or the 100 times gain may be selected by means of a switch. Two stages of amplification are employed with sufficient negative feedback to insure that normal variation of battery voltages, changes in tubes and other circuit parameters do not affect the gain by more than 2 per cent.

While the Decade Amplifier was designed primarily for use with the Ballantine Model 300 Voltmeter it may be used within the limits of its frequency response of 10 to 150,000 cycles with other Ballantine Voltmeters or for other applications when stable voltage gains of 10 or 100 are desired.

BATTERIES AND TUBES — Two Type 1U4 tubes are used. Each tube is operated from a separate 1½ volt "A" battery — Eveready No. 742 or equivalent. The 135 volt "B" battery supply is obtained from two 67½ volt batteries connected in series — Eveready Minimax No. 467 or equivalent. The "A" batteries should be replaced when their voltage drops below 1.15 volts on load and the "B" battery should be replaced when the voltage drops below 108 volts on load when measured on a meter having a resistance of at least 10,000 ohms per volt.

A meter is provided on the panel to indicate the condition of the batteries. When the "OFF, A-B BATT, ON" switch is switched to the "A BATT" position, the meter will read the voltage of one "A" battery. When the "OFF, A-B-BATT, ON" switch is switched to the "B BATT" position, the meter will indicate the condition of the "B" battery. If the meter pointer reads to the left of that portion of the scale marked in red, the voltage of the battery being tested is too low for satisfactory operation and the battery should be replaced. Both "A" batteries should be replaced at the same time.

It is recommended that depleted batteries not be allowed to remain in the case because of the possibility that they may swell and become difficult to remove.

OPERATION—The instrument is ready to operate as received and is turned on by rotating the "OFF, A-B-BATT, ON" switch to the "ON" position. The gain is selected by means of the switch to the right of the meter.

In order to guard against the introduction of spurious voltages the input terminal marked GND should be grounded. However, the amplifier may be used in networks where it is not permissible to ground the GND terminal provided the small capacitance of the amplifier case to ground or to surrounding objects introduces neither appreciable loading on the network nor detectable spurious voltages in the network from external A.C. fields. Whenever the amplifier is used without a ground, the possible grounding effect of whatever load is connected to its output terminals on an ungrounded or balanced to ground network working into its input terminals must be considered because the output terminal of the amplifier marked GND is directly connected to the input terminal marked GND.

MEASUREMENT OF SMALL ALTERNATING POTENTIALS — When used with the Model 300 Voltmeter, AC voltages down to 0.1 millivolt may be measured with the 10 times gain. Theoretically, with the 100 times gain, voltages down to 0.01 millivolt (10 microvolts) should be measurable, but as a practical matter the random noise level is such as to make the measurement of voltages this low somewhat in error. The noise level of the Model 220C when referred to the input terminals is primarily a function of the amplifier bandwidth, or the input circuit bandwidth, whichever is the narrower. With the input terminals open circuited but shielded the noise level is approximately 25 microvolts; with the input circuit short circuited the noise level is approximately 8 microvolts. The actual noise level obtained in any particular application can be determined experimentally by simulating the input conditions of R, C and L and noting the noise level which exists. Table I is a listing of source impedance, probable noise level and measured voltages below which noise will cause more than a +10% error.

TABLE I

Source R (ohms)	+Noise Level (μv)	E min (μv)
* 500,000	18	40
50,000	14	31
5,000	10	22
500	9	20
0	8	17.5

* The positive noise error in the measured voltage will be cancelled to some extent by the negative loading error of the amplifier when working from source impedances above 50,000 ohms. The noise level in the above table is based on an input capacitance of 15 pF. Additional capacitance, as will almost always occur in practice, will further reduce the noise level when the source impedance is high.

INPUT AND OUTPUT IMPEDANCES — The input impedance corresponds to a resistance of 5 megohms shunted by a capacitance of 15 pF.

The output impedance corresponds to a resistance of less than 900 ohms in series with 2 μF for the 10 times gain and to a resistance of less than 7,000 ohms in series with 2 μF for the 100 times gain. If the output of the Decade Amplifier is fed to loads having a different shunt capacitance of (30 pF) or a lower shunt resistance (½ megohm) than the Model 300 Voltmeter, its gain may vary more than 2% at the extreme ends of its frequency range.

GAIN ADJUSTMENT — The amplifier gain is carefully adjusted before the instrument leaves the factory. In case, however, this adjustment is accidentally disturbed a screw-driver gain adjustment is provided whereby the proper setting may be restored. This adjustment may be checked by means of an accurately calibrated 10 to 1 potential divider or by means of a suitably accurate electronic voltmeter, such as the Ballantine Model 300. If the gain adjustment is made at any convenient frequency in the range from 200 cycles to 100,000 cycles, the gain of the amplifier will be uniform within 2% over its entire frequency range for either the 10 times or the 100 times setting of the gain selector switch.

OVERLOAD CHARACTERISTICS — For maximum accuracy over the entire frequency range, voltages in excess of 50 millivolts should not be impressed across the input terminals of the amplifier. This corresponds to an output voltage of ½ volt on the 10 times range and 5 volts on the 100 times range.

SHIELDING — When using the extreme sensitivity of the amplifier, and especially when measurements are being made on high impedance circuits, it may be necessary to shield the high potential input terminal from extraneous fields, and for this purpose the General Radio Type 274-NF Patch Cord and Type 274-ND Shielded Plug is particularly recommended.

SERVICING — If trouble develops in the amplifier the condition of the batteries should first be checked. If the batteries are in good condition and there is no evidence of noise or bad connections the tubes should be changed. If this does not clear up the trouble the instrument should be returned to us for inspection and repair. DO NOT RETURN THE INSTRUMENT, HOWEVER, WITHOUT FIRST WRITING TO EXPLAIN THE TROUBLE.

REPLACEMENT PARTS LIST

REFER TO MODEL 200C SCHEMATIC DIAGRAM, ISSUE MC-576D

B.L. Part No.	*Circuit Symbol*	*Resistors*	*Manufacturer*
1388	R1	5,000,000 ohms, Type CP-½, 2%	Wilkor
1822	R2	5,000 ohms, Type W-5000	I.R.C.
1363	R3	600 ohms, Type CP-½, 1%	Wilkor
1336	R4	1,500 ohms, Type CP-½, 1%	Wilkor
1057	R5	1,000 ohms, Type EB, 5%	Allen-Bradley
1309	R6	100,000 ohms, Type CP-½, 1%	Wilkor
1022	R7	220,000 ohms, Type EB, 10%	Allen-Bradley
1010	R8	1,000,000 ohms, Type EB, 5%	Allen-Bradley
1057	R9	1,000 ohms, Type EB, 5%	Allen-Bradley
1305	R10	200,000 ohms, Type CP-½, 1%	Wilkor
1327	R11	5,000 ohms, Type CP-½, 1%	Wilkor
1311	R12	50,000 ohms, Type CP-½, 1%	Wilkor
1007	R13	2,000,000 ohms, Type EB, 5%	Allen-Bradley
2673	R14	267,000 ohms, Type CP-½, 1%	Wilkor
1003	R15	510,000 ohms, Type EB, 5%	Allen-Bradley
		Condensers	
2142	C1	.1 μF, 200 v, Type 109P10492	Sprague
2056	C2	50 μF, 3 v, Type BBR-503	Cornell-Dubilier
2050	C3	8 μF, 250 v, Type BR-825	Cornell-Dubilier
2072	C4	80 μF, 150 v, "Atom"	Sprague
2109	C5	.047 μF, 200 v, Type 109P47302	Sprague
2056	C6	50 μF, 3 v, Type BBR-503	Cornell-Dubilier
2120	C7	.47 μF, 200 v, Type 109P47402	El-Menco
2402	C8	65 to 340 pF, Type X303	El-Menco
2400	C9	0-30 pF, Type 461	El-Menco
2317	C10	2 μF, 200 v, Type 621M	Goodall
		Batteries	
3091	A1, 2	1-½ volt — Eveready 742	
3092	B1	67-½ volt — Eveready 467	
		Meter	
3155	M1	Weston Model 506, 0-3 volts DC	
		Tubes	
3111	V1-2	Type 1U4, General Electric Co.	

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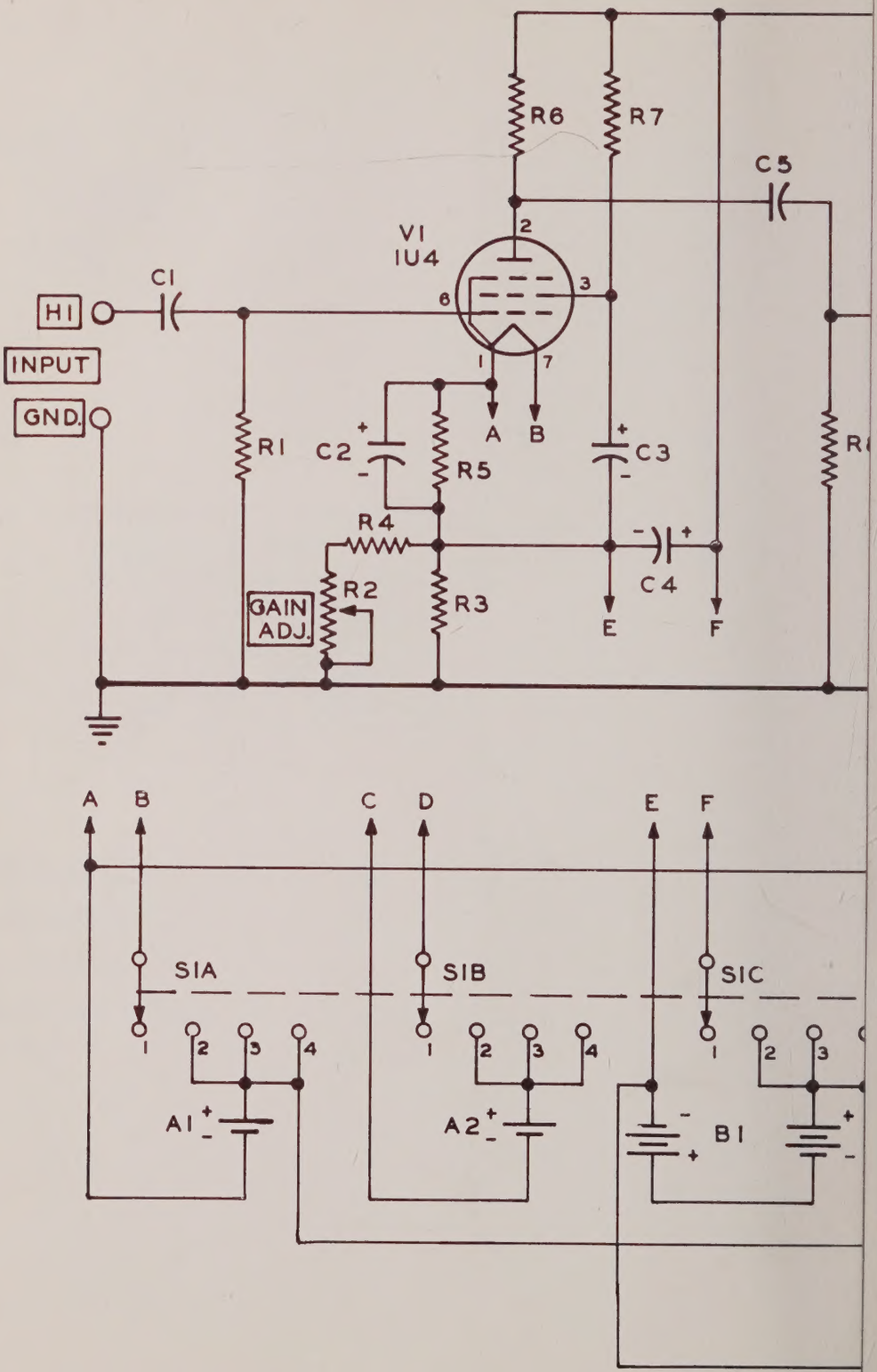
R6
R7
C5
V1
1U4
2
3
6
1
7
C1
H1
INPUT
GND.
R1
C2
A
B
C3
R5
R4
R2
GAIN
ADJ.
R3
C4
E
F
A
B
C
D
E
F
S1A
S1B
S1C
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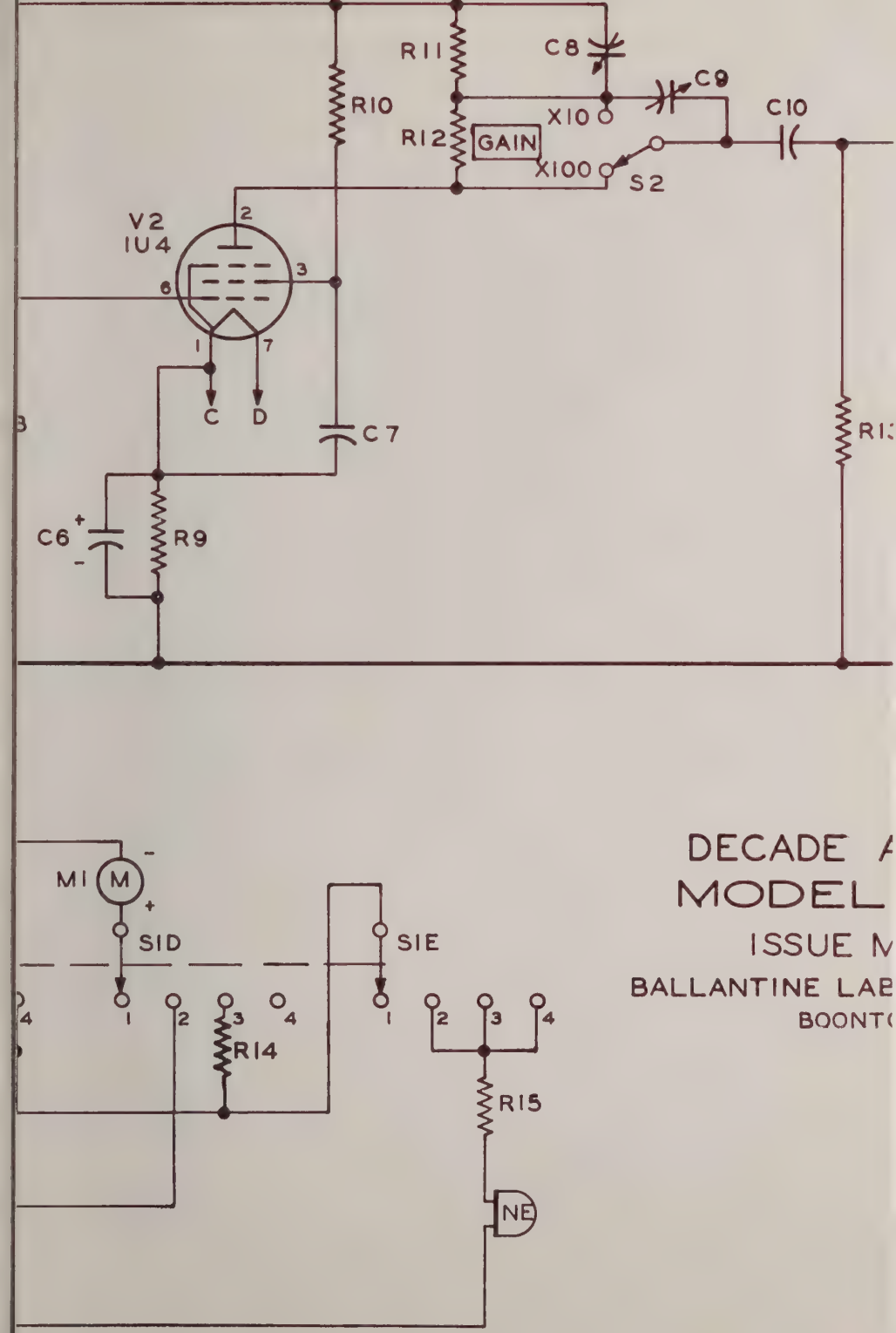

DECADE A
MODEL
ISSUE M
BALLANTINE LAB
BOONT

S1 POSITION	FUNCTION
1	OFF
2	A BATT.
3	B BATT.
4	ON

AMPLIFIER
220C
IC-576 D
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ON, N. J.

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